n times the conductivity outside; if the specific heat inside is s times the specific heat outside; if the density inside is d times the density outside; then Kelvin's age of the earth is increased $n\,s\,d$ times. . . It is not likely that Dr. Weber's rate of increase would be constant to such a temperature as 4000° C.; but the electric analogue allows us to imagine a greater and greater rate of increase at higher temperatures; therefore it is in Lord Kelvin's interest to take Weber's rate. Now at 4000° C. the conductivity would be [leaving out eurite, which seems abnormal and too much in my favour], thirty times as great as it is at the surface; the specific heat would be 14½ times as great, and taking the density as three times, we have, even for a *perfectly solid* earth an age 1300 times the age given by Lord Kelvin.

2. In answer to your second question, Lord Kelvin completely destroyed the uniformitarian geologists, and not one now exists. It was an excellent thing to do. They are as extinct as the dodo or the great auk.

I have met many advanced geologists, and not one of them demands more than 1,000,000,000 years. Probably Sir Archibald Geikie is the most representative of the geologists who have studied this question, and he never (in recent years) seems to have desired even as much as 1,000,000,000 years. (See his address as President of the British Association.) The biologists have no independent scale of time; they go by geological time. According to Huxley, less than 1,000,000,000 years is enough as the age of life on the earth.

But surely the real question now is not so much what the geologists care about, as—Had Lord Kelvin a right to fix 10^8 years, or even 4×10^8 years, as the greatest possible age of the earth?

Yours truly,
John Perry.

December 6, 1894.

Dear Prof. Tait,—Prof. Fitzgerald has pointed out to me that the five rocks given by Everett are not to be found in his 1891 edition. I quoted from his 1886 edition. I therefore wrote to Everett, asking why he had left them out—was there a mistake? He writes to say: "I copied Weber's data from a copy of his paper which was, and may be still, in my possession, having been sent me through the post, probably by the author, or possibly by Dr. Stapff, the geologist of the St. Gothard Tunnel, with whom I had much correspondence in underground temperature. You seem to assume, in writing to Tait, that I picked out samples of Weber's results; but my recollection is that I gave everything without reservation.

"I did not reproduce his results in the 1891 edition, and I cannot remember all my reasons for dropping them. On comparing them with other people's, which I give, they appear to be much too small. There is such a mass of conduction results in my book, that I was on the look-out for something that might be omitted.

"I have just referred to the foreign translations of my book. The German edition, published in 1888, gives only a page of conductivities of solids, and includes among them one of R. Weber's, namely Glimmerschiefer ·000733 + ·000010 t. The Russian edition, brought out by editors who took tremendous pains in verifying and correcting references, gives my list of Weber's results exactly as it stands in my book, the sign of the temperature coefficient being positive in every case. I do not know of any direct evidence as to the variation of rock conductivity with temperature except R. Weber's, but there is something approaching to direct evidence in the comparison of George Forbes' results with Herschel and Dunn's (see my 1891 edition, pp. 126, 129). Forbes found at – 10° C. the conductivity of white marble to be ·00115, black marble ·00177. Dunn and Herschel found at the temperature of hot water, marbles, &c., ·0047 to ·0056 (see Forbes' remark, quoted at p. 129).

"You have built a very lofty edifice on the basis of Weber's results, and extrapolation is proverbially a risky process, but I consider you have established a strong presumption in favour of the increase of rock conductivity with temperature."

I did not know, when writing to you on November 26, that the Rev. M. H. Close, M.A., had (R. Dublin Soc., Feb. 1878) put forward in great detail the reasons which I gave you shortly, against the tidal retardation argument. I thought they were my own. I notice that this gentleman assumes that increased conductivity inside would help Lord Kelvin, and indeed I cannot help thinking that, without mathematics, almost anybody would be of the same opinion—in spite of what you say in your first letter. I know that Lord Kelvin himself did not seem to think me right when—after I had sent him the documents—I talked to him at Cambridge.

I remain, yours truly,
John Perry.

Copy of a Letter from Lord Kelvin.

The University, Glasgow, December 13, 1894.

Dear Perry,—Many thanks for sending me the printed copy of your letter to Larmor and the other papers, which I found waiting my arrival here on Saturday evening. I have been much interested in them and in the whole question that you raise, as to the effect of greater conductivity and greater thermal capacity in the interior. Your $n^2 \div m$ theorem is clearly right, and not limited to the case of the upper stratum being infinitely thin. Twenty or thirty kilometres may be as good as infinitely thin for our purposes. But your solution on the supposition of an upper stratum of *constant* thickness, having smaller conductivity and smaller thermal capacity than the strata below it, is very far from being applicable to the true case in which the qualities depend on the temperature. This is a subject for mathematical investigation which is exceedingly interesting in itself, quite irrespectively of its application to the natural problem of underground heat.

For the natural problem, we must try and find how far Robert Weber's results can be accepted as trustworthy, and I have written to Everett to ask him if he can send me the separate copy of Weber's paper, which it seems was sent to him some time before 1886; but in any case it will be worth while to make farther experiments on the subject, and I see quite a simple way, which I think I must try, to find what deviation from uniformity of conductivity there is in slate, or granite, or marble between ordinary temperatures and a red heat.

For all we know at present, however, I feel that we cannot assume as in any way probable the enormous differences of conductivity and thermal capacity at different depths which you take for your calculations. If you look at Section 11 of "Secular Cooling" ("Math. and Phys. Papers," vol. iii. p. 300), you will see that I refer to the question of thermal conductivities and specific heats at high temperatures. I thought my range from 20 millions to 400 millions was probably wide enough, but it is quite possible that I should have put the superior limit a good deal higher, perhaps 4000 instead of 400.

The subject is intensely interesting; in fact, I would rather know the date of the *Consistentior Status* than of the Norman Conquest; but it can bring no comfort in respect to demand for time in Palæontological Geology. Helmholtz, Newcomb, and another, are inexorable in refusing sunlight for more than a score or a very few scores of million years of past time (see "Popular Lectures and Addresses," vol. i. p. 397).

So far as underground heat alone is concerned you are quite right that my estimate was 100 millions, and please remark ("P. L. and A.," vol. ii. p. 87) that that is all Geikie wants; but I should be exceedingly frightened to meet him now with only 20 million in my mouth.

And, lastly, don't despise secular diminution of the earth's moment of momentum. The thing is too obvious to every one who understands dynamics.

Yours always truly,
Kelvin.

JUPITER.

Jupiter being now near opposition, and having an apparent diameter of 47″·7, is displayed as a very brilliant object in the heavens, and his northerly declination of 23 degrees enables him to remain above the horizon for a period of 16½ hours.

During the few ensuing months, the observation of his belts and spots will enlist a large amount of attention, for there is probably no other planetary object which exhibits a more diversified and variable aspect. One feature of the present observations will be important as enabling comparisons to be made as to the rates of motion of the various white and dark spots in this and preceding oppositions. No doubt many of the surface markings now existing are identical with those observed some years ago. From 1878 to 1882 the prominent apparition of the red spot incited observers to fully investigate the phenomena of the different formations, and they were found to be very discordant in their rates of velocity. The red spot and equatorial white spots were evidently subject to a marked retardation, causing their rotation periods to increase with the time.

As to the red spot, the slackening rate of motion it exhibited in the earlier years of its presentation, appears not to have been maintained since 1886, for Mr. Marth's adopted period of 9h. 55m. 40·63s. (equivalent to a daily rate of 870°·27) has correctly represented its mean motion during the last eight years. There have been, it is true, some marked deviations from the mean rate, for in the years from 1886 to 1890 the motion became accelerated and corresponded to a rotation period of about 9h. 55m. 40·2s., but in the three following years it slackened again, and since 1891 the period has been about 9h. 55m. 41·5s.

At the present epoch the spot is extremely feeble in its visible outlines, but on a really good night its elliptical form can be distinctly traced, and it does not appear to have materially changed either in its shape or dimensions since 1879. Its following end is decidedly the plainest, and its southern borders have lately been conjoined with a grey belt in about latitude 30° south. The commingling of the spot and belt has been noticed here on previous occasions, and it is certain that on its southern side the spot exerts very little of the repellent influence so often ascribed to it. On the contrary, the belts on the equatorial side of the spot always run clear, and abruptly bend north to allow of a clear white interval between the spot and belt. The S. border of the spot and S. belt were apparently in touch early in the past autumn, for Mr. Barnard, observing the red spot with the 36-inch refractor of the Lick Observatory, says: "The belt south of it seems to be in contact, if it does not actually overlap it slightly." The same thing was noticed as long ago as October 31, 1893, by the aid of the 16-inch refractor of the Goodsell Observatory, Minnesota, when the observers wrote "the great red spot was seen by us, and the colour was exactly the same as that of the belt just to the south of it, and the two objects merged into one another without the slightest change in intensity of colour."

The spot now arrives at mid-transit two or three minutes after Mr. Marth's zero meridian, as the following observations made here will indicate:—

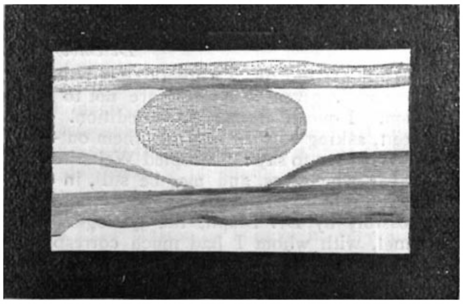
1894	Mid-transit of spot. h. m.	Follows Marth's zero meridian. m.	Long. of spot. °
November 25 ...	... 10 50 ...	... 4·2 ...	... 2·9
December 12 ...	... 9 46 ...	... 1·2 ...	... 0·7
19 ...	... 10 33 ...	... 3·5 ...	... 2·1

It is well known that the perception of a delicate planetary marking depends in a very great measure on the quality of the definition. On an indifferent night the red spot is practically invisible, but with steady air and a sharp image the familiar pinkish ellipse, now representing that object, shows up distinctly in the remarkable concavity of the great southern equatorial belt. The latter configuration always offers an excellent guide to the position of the spot, but its appearance is not symmetrical, the following side of it being much more strongly developed than the side preceding the spot.

The impending disappearance of the latter has been suggested by several observers from its loss of tone during the last few years, but there seems to be no tangible reason to suppose that we are on the point of losing this truly singular object. It is indeed utterly impossible to predicate anything definite as to its future history. The facts gleaned during past observations are not of a character to guide us to any reliable conclusion. Its present faintness may be but the prelude to a more marked manifestation, for variation of tint is certainly one of its leading peculiarities. It is doubtless the same object as the the ellipse seen by Gledhill and Mayer in 1869 and 1870, and quite possibly the same formation was figured by Dawes in 1857 and in subsequent years. At any rate the resemblance of the objects is eminently suggestive, and altogether too striking to be disregarded.

About fifteen years ago the equatorial zone of Jupiter exhibited phenomena proving it to be in a state of considerable activity. There were white and dark spots, wisps of dark material, veins of bright matter, and other irregularities all in condition of rapid change, and imparting a very broken and variegated aspect to the northern side of the great southern equatorial belt. To-day the indications are essentially different. The light tint of the equator seems pretty even, and exhibits few noticeable irregularities. Precisely on the equator there is a dark belt like a narrow pencil line, but it is not now continuous right round the disc. The chief seat of energy appears to have been transferred to the northern side of the great northern equatorial belt.

Dark spots (some of them almost black, like satellite shadows) and white patches, with other details of structure, are plentifully arrayed in the northern equatorial belt. The white spots I observed here in 1885 and 1886, and they have persistently maintained themselves ever since. Their rotation period in 1886 was about eight seconds less than that of the red spot, but in 1890–91 I found it only 2·6 seconds less. At present the period is still a little less, and there are a number of black spots in the same latitude, and subject to the same drift. One of the most conspicuous of the black spots precedes the red spot about 3h. 20m., and one of the chief white spots precedes the red about 2h. I have secured the following observations of this pair of objects:—



1894 November 25, 10h. 9m., 10-inch reflector, power 252.
Region of Red Spot.

Black spot.			White spot.		
1894.	Mid transit. h. m.	Long. °	1893.	Mid transit. h. m.	Long °
Nov. 5 ...	10 57 ...	239·1	Nov. 23 ...	10 0 ...	303·4
15 ...	9 10 ...	238·2			
17 ...	10 47 ...	237·6	1894. Nov. 5 ...	12 16 ...	286·9
29 ...	10 39 ...	237·7	15 ...	10 31 ...	287·2
Dec. 4 ...	9 42 ...	235·1	25 ...	8 45 ...	287·0
18 ...	11 14 ...	236·5	Dec. 19 ...	8 24 ...	284·2

The northern temperate belt on which in 1880 and 1891 many rapidly moving black spots appeared, is now in close contiguity with the great northern belt, and blends with it in certain places. A few years ago the two belts were separated by a bright zone.

There is a narrow spotted belt in about latitude 35° north. In 1892 and on subsequent occasions I noticed this belt beaded with numerous dark spots, but I have not made a sufficient number of observations to determine the rotation period. This belt forms a delicate object; it is very narrow, and the spots extremely small. In bad air it is quite obliterated. Only a few observers appear to have noticed this northerly belt and its beaded aspect, but it has been an interesting feature of the planet during the last two years.

In the southern hemisphere and further south than the red spot, there are some dark condensations and white spots, with a rotation period of about 9h. 55m. 20s.

The S. region of the great N. belt exhibits interruptions in the form of very bright streams of material dividing the belt in an oblique direction relatively to the equator. These appearances show rapid changes from day to day, and I have not yet computed the rotation period satisfactorily, but it is obviously very different to that of the red spot. Five observations of these luminous encroachments on the belt have been secured here, as follow :—

		Mid-transit. h. m.	Long. °
November	8	11 0	332·0
	15	12 31	359·7
	29	9 47	206·1
December	4	8 1	174·1
	19	9 33	325·8

It is intended to make a closer study of the variable aspect and rate of velocity of these singular formations.

We may depend upon it, from the number of interesting markings displayed on the planet, that there will be no abatement of useful observations during the present apparition. There is always something new to record, and objects previously known require attentive watching with reference to the differences in their rotation periods. Whether the theorem that the longer an object remains visible the slower becomes its velocity is true or not, cannot be definitely said, but the behaviour of the red spot has not altogether supported the idea. A vast amount of new evidence is required as to the phenomena affecting the surface markings of Jupiter; he presents an ample field both for the observer and the theorist.

W. F. DENNING.

NOTES.

SCIENCE is represented in the list of New Year honours by Mr. W. H. White, C.B., F.R.S., the Director of Naval Construction, who has been promoted to a Knight Commandership of the Bath. Two other Fellows of the Royal Society, Dr. J. Russell Reynolds, President of the Royal College of Physicians, and Dr. Eric Erichsen, formerly President of the Royal College of Surgeons, have each had the honour of a Baronetcy conferred upon them.

THE cross of Commander of the Order of the Ernestine House of Saxony, second class, has been conferred upon Dr. Edward S. Holden, Director of the Lick Observatory, for his services to science. This Order was founded in 1690, reorganised in 1833, and is conferred upon persons holding high official positions, either military or civil. At present there are eighteen Commanders of this class in Germany.

THE fund for the proposed statue to the late Dr. Charcot will probably soon be closed; as it is announced that thirty-five thousand francs have been collected, and this is sufficient to warrant the ordering of the statue. In all probability, a statue will be erected to Helmholtz, for it is reported that, at the recent celebration in Berlin, the German Emperor offered to head a subscription list for that purpose with a donation of ten thousand marks.

THE Paris Chemical Society has (says the *Chemist and Druggist*) recently come into possession of a legacy from M. Rigout, formerly of the École des Mines, who bequeathed to the Society an income of twelve hundred francs per annum, of which a portion is to be set aside for an annual prize to be awarded in connection with inorganic chemistry. M. Rigout declines to allow his name to be attached to this legacy, but asks to have it named the Edouard Rivot prize, in memory of his former Professor. It is worthy of mention that a short time ago M. Silva, late Professor at the School of Arts and Manufactures, left his library and modest fortune to the same Society "out of gratitude for the kindness met with in the French scientific world."

THE death is announced of M. Frederik Johnstrup, Professor of Mineralogy in Copenhagen University, at seventy years of age.

DR. F. KOHLRAUSCH, Professor of Physics in Strassburg University, has been appointed Director of the Imperial Physico-Technical Institute at Berlin, in succession to Helmholtz.

INCREASED facilities for instructing in the science and art of agriculture are gradually being given to the Technical Education Committees in various parts of the country. We are glad to see it announced that Earl Cowper, chairman of the Hertfordshire County Council, has offered to place a farm of nearly 300 acres, with residence and buildings, at the disposal of the Council, rent free, for the purpose of providing practical instruction in agriculture, on condition that the County Council stock the farm and work it. Lord Cowper has also undertaken to erect a laboratory and the necessary dormitories. A sub-committee of practical agriculturists has been appointed to consider his lordship's offer and report to the Council upon it.

A NEW society has just been formed in Paris for the purpose of subterranean exploration, to be called "La Société de Spélæologie." Its projector is M. E. A. Martel, whose works, "Les Abîmes" and "Les Cévennes," may be familiar to some readers of NATURE. In his papers read before the French Association for the Advancement of Science at Besançon in 1893, M. Martel warmly set forth the claims of underground investigation, and the light that might thereby be thrown upon geology, palæontology, and kindred subjects. Indeed, as readers of the works just mentioned are aware, very interesting discoveries have already been made, notably that of the underground rivers of Bramabiau (Gard) and of Padirac (Lot). Among those who have joined the Société de Spélæologie are several well-known men of science. All information is to be obtained of M. Martel, 8 rue Ménars, Paris.

THE idea of holding International Mathematical Congresses is crystallising into shape. Prof. Vassilief, of Kazan, has suggested an assembly of mathematicians in 1896, in order to definitely decide the organisation of such congresses. The matter was pushed a little further at the Vienna meeting of the Deutsche Mathematiker Vereinigung, in September last, when it was unanimously resolved that the committee of the Mathematical Union should take part in framing the necessary arrangements; and the Mathematical section of the French Association for the Advancement of Science have also expressed their support of the scheme. A circular now informs us that the Editors of the *Intermédiare* will be glad to receive the names of mathematicians who are in favour of international meetings of the kind suggested. M. C. A. Laisant's address is 162 Avenue Victor-Hugo, Paris; and that of M. E. Lemoine, 5 rue Littré.

THE *Johns Hopkins University Circular* states that it is proposed to collect the physiological papers and addresses of Prof. Martin, and publish them as one of the memoirs of the Biological Laboratory of the Johns Hopkins University. This plan has been adopted in response to suggestions from a number